



SPECIFICATION

Stationary Armature Machine

Cross Reference to Related Applications

3,870,914 03/1975 Walker, Alan 310/219

4,573,001 02/1986 Lin, Banchien 318/695

Background of Invention

[0001] Conventional Brush Type DC Electric Motors have been used for many years in power tools, electric scooters & vehicles, appliances and other assorted machinery. The main parts are comprised of an armature, field structure, yoke or housing and brush rigging. The armature being the rotating part of the motor consists of a laminated steel core having slots as a means for holding coils of wire electrically connected to a commutator affixed to a common shaft. Electrical current from a power source flows through stationary magnetic field coils and brushes affixed to a housing and through armature windings affixed to a rotor as a means for generating a rotating magnetic field magnetic wave that drives the rotor. This arrangement generates a large amount of heat at the center of the motor having limited means for heat abatement through the air gap, field structure and housing such that direct current brush type motors are much larger than ac motors (and BLDC) of the same power rating. The armature and field structure of conventional brush type dc machines are connected electrically in series, shunt, compound and permanent magnet configurations. Brushless dc (BLDC) motors having a rotating field and stator electrically connected to a multiphase electronic inverter as a means for electronic

commutation inducing a rotating magnetic field that drives said rotor. BLDC motors having a stator affixed to said housing for increase thermal abatement operates more efficiently using dc power inverted into ac power by a multi-phase electronic inverter.

Summary of Invention

[0002] The Stationary Armature Machine (SAM) has a stationary armature similar to the BLDC motor, and a stationary commutator affixed to the frame or housing for increased heat abatement. The concept behind SAM is simple: Reverse the physical position of the armature and field structure relative to the other by attaching the armature (and commutator) to the housing and the field structure (and brush assembly) to the shaft in a manner similar to BLDC motors. By making the armature (and commutator) stationary, the current carrying conductors can be made much larger as a means for increasing current carrying capacity at low voltages. Because SAM's armature coils are stationary, they are unaffected by centrifugal forces generated by the rotor's high rotating velocities. Heat generated by the armature is easily abated through the housing increasing its ability to transform electrical energy into mechanical energy efficiently. Hybrid vehicles and battery powered household /garden appliances are becoming more assessable with the advent of high energy permanent magnets, lithium ion/NiMH battery technology and high power multiphase inverters. Conventional DC brush type motors are unable to meet the demands of hybrid vehicles and appliances that required large amounts of power and operate at high rotating speeds such as leaf blowers and upright vacuum cleaners because of size, volume or weight constraints. Conventional low voltage high current dc motor armatures require large conductors that are subjected to tremendous centrifugal forces generated by the high rotating velocities. The rotating armature must be large enough to dissipate heat generated by

high currents increasing the overall size relative to Brushless dc motors (BLDC) and Controlled Slip Induction motors (IM). BLDC and IM motors use a "stationary armature" (stator) that requires an external means of excitation such as a dc to ac multiphase (electronic) inverter at great expense. By comparison: (1) SAM does not require closed loop feedback for rotor positioning such as resolvers, encoders or hall-effect sensors; (2) Develops very high starting torque; (3) Low rotor Inductance and inertia when compared to conventional dc motors. SAM uses a unique brush cooling technique to reduce brush/commutator wear and uses a stationary armature as a means for increased power output, improved thermal abatement and reduced size similar to the BLDC motor. SAM, unlike BLDC and IM's uses a mechanical rotating brush and stationary commutator as a means for excitation instead of an external multiphase inverter increasing its cost effectiveness. Battery powered high output (1000 watts) upright vacuum cleaners and leaf blowers powered by SAM take advantage of its stationary armature and large current carrying conductors to keep the overall size comparable to that of BLDC technology. Applications include: 1) Power tools & appliances (120 vac & dc battery powered)- up to 1500 watts; 2) Electric scooters & vehicles (battery powered) up to 200 Kilowatts; 3) Uninterruptible Power Supply (UPS) prime mover up to 2,000 Kilowatts; 4) Traction drives for heavy machinery up to 20,000 Kilowatts; 5) Power generators & motors up to 60,000 kilowatts and motor / generator combinations for use in hybrid vehicles up to 500 Kilowatts.

Brief Description of Drawings

[0003] Figure 1 shows the front view of the rotating brush assembly in a 2-pole configuration. Figure 2 shows the front view of the stationary commutator, slip rings and rotating brush assembly. Figure 3 shows the front view of the rotating brush assembly in a 4-pole configuration. Figure 4 shows the side view of the stationary armature machine in a

shunt wound configuration. Figure 5 shows the side view of the stationary armature machine in a series wound configuration. Figure 6 shows the front view of the internal brush and stationary commutator detail without counterweights. Figure 7 shows the front view of the internal brush and stationary commutator detail with counterweights. Figure 8 shows the front view of the radial stationary commutator and brush assembly. Figure 9 shows the front view of the external brush assembly with counterweights. Figure 10 shows the side view of the stationary armature machine in a permanent magnet configuration. Figure 11 shows the side view of the stationary armature machine in a separately excited configuration. Figures 12 through 15 show schematic representations of the series wound, shunt wound, permanent magnet and separated excited machines.

Detailed Description

[0004] Figure 1 shows the front view of a 2-pole rotating brush assembly as a means for conducting electric current from a power supply to the armature windings and field coils. Figure 1-1 shows the front view of the rotating brush assembly housing capable of providing physical support and electrical isolation of the attached components. Figure 1-2 shows a negative polarity copper brush holder attached to figure 1-1 as a means for guiding said brush and providing additional electric current shunting capacity. Figure 1-3 shows a positive polarity copper brush holder as a means for guiding said brush and providing additional electric current shunting capacity.

[0005] Figure 1-4 shows a spring as a means for keeping said brush in contact with said commutator. Figure 1-5 shows the fulcrum of the brush keeper as a means for supporting said brush keeper and as means for providing a moment opposite that applied from centrifugal forces acting on said brush. Figure 1-6 shows the counter weight portion of

figure 1-12 as a means for applying a moment about said fulcrum equal an opposite to that applied by the figure 1-7 brush being forced outward by said centrifugal force. Figure 1-12 shows a conductive brush keeper and shunt as a means for keeping the brush in contact with the stationary commutator during high-speed operation to counteract centrifugal forces acting on said brushes.

[0006] Figures 1a and 1b show the bottom and top views of figure 1. Figures 1c shows a cutaway of fig 1. Figure 2 shows the front view of the stationary commutator, slip rings and rotating brush assembly. Figure 2-8 shows the base of the stationary commutator slip ring assembly as a means for support and electrical insulation between slip rings and commutator segments. Figure 2-9 shows commutator comprised of segments electrically insulated from each other and electrical connected to individual armature coils. Figures 2-10 & 11 shows the negative and positive polarity copper slip rings as a means for conducting current from a power source through said rotating brushes making contact with said stationary commutator as a means for generating a rotating magnetic field driving said rotor. Figures 2-13 & 14 show the negative and positive polarity power leads. Figure 3 shows the front view of a 4 pole variation of the 2 pole rotating brush assembly having brushes arranged 180 electrical degrees apart being physically arranged 90 degrees apart. Figure 4 shows the side view of the shunt wound stationary armature machine.

[0007] Figure 4-15 shows the lead that connects the one armature coil to one commutator segment. Figure 4-16 shows the laminated steel armature core being affixed to the machine housing and encompassing said rotor as a means for abating heat generated from copper losses within said armature. Figure 4-17 shows the armature windings placed inside slots within said core. Figure 4-18 shows the rotating electromagnetic field structure. Figure 4-

20 shows the field structure winding. Figures 4-21 & 22 show the field structure leads as a means for conducting power from the brush holders to the rotating field structure winding.

Figure 4a shows the front view of said motor.

[0008] Figure 5 shows the side view of a series wound stationary armature machine.

Figure 5-23 shows the lead of a copper brush holder and non-conductive brush keeper figure 5-24 being isolated from brush holder figure 5-25 as a means for conducting electric current through the rotating field and armature in a series electrical connection. Figure 5-24 shows a non-conductive brush keeper as a means for isolating the flow of electric current from a power source to the rotor coil via brush assembly figure 5-25 returning through brush assembly figure 5-23 continuing through said commutator assembly. Electric current flows through said armature to the opposite brush assembly having a shunt brush keeper continuing through the other stationary slip ring and out to the other terminal of said power source. Figure 6 shows the front view of the stationary commutator having a cylindrical shape and rotating brush assembly whereas the rotating brush assembly contacts the stationary commutator on the inside diameter of said commutator assembly. High-speed rotation induces centrifugal forces that act to force said brushes against the inside diameter of the stationary commutator assembly.

[0009] Figure 6a show a side view cutaway of figure 6. Figure 7 shows the front view of the stationary commutator and rotating brush assembly having a rotating brush assembly comprised of two brushes permanently affixed a single copper shunt between the armature and slip rings as a means for conducting high electric current at low voltage and high rotating velocities. Wherein figure 7-7 brush is attached to brush keeper shunts figures 7-2 & 3. Figure 8 shows the front view of the radial stationary commutator and brush

assembly, wherein the commutator and slip rings are arranged in a concentric pattern having a flat or conical surface as a means for increasing the cross sectional area through which electric current flows.

[0010] Figure 8a shows the side view cutaway of figure 8. Centrifugal forces acting on the brushes generated by high-speed rotation have little effect on the pressure at the point where the brushes make contact with the said commutator. Figure 9 shows the rotating brush assembly whereas brush keepers figures 9-2 & 3 and brushes figure 9-7 are permanently attached to each other. Centrifugal forces acting on the brushes generated by high speed rotation is counteracted by centrifugal force generated by a counter weight figure 9-6 limiting the pressure at the point where the brushes make contact with the said commutator.

[0011] Figure 10 shows the side view of the permanent magnet variation of the stationary armature machine whereas the permanent magnet having characteristics similar to that of said shunt wound machines. Figure 11 shows the side view of the separately excited shunt wound stationary armature motor having a third regulating stationary slip ring figure 11-28 as a means for providing regulated current flow through lead figure 11-27 to said field structure from an external regulator. Figure 11-26 shows a non-conductive brush keeper and copper brush holder isolated from the adjacent brush and holder as a means for conducting electric current from said regulating slip ring through lead figure 11-21 to said rotating field.

[0012] Electric current continues to flow through said stationary commutator segment to the opposite rotating brush assemble. Said non-conductive brush keeper isolates the flow of electric current from said regulating source and said power source while the opposite

rotating brush assembly having a shunt brush keeper such that the electric current flows from said rotating field coils and stationary armature in a shunt electrical connection flowing out to the other terminal of said power source completing the circuit. Figure 12 shows an electrical schematic representation of the stationary armature machine in said series wound connection wherein the same electric current from a power source flows through both the field coil and the armature such that torque is proportional to the square of the current. The series wound configuration is useful in applications that require high starting torque.

[0013] Figure 13 shows an electrical schematic representation of the stationary armature machine in said shunt wound connection whereas the smaller part of the total electric current flows through the field coil which has a larger impedance and wherein the larger portion of the total current flows through the armature which has a much lower impedance such that torque is directly proportional to the current flowing through the armature. Said shunt wound configuration is useful in applications that require moderate torque and precise speed control.

[0014] Figure 14 shows an electrical schematic representation of the stationary armature machine whereas electric current flows through the stationary armature only. Said permanent magnet configuration is useful in applications that require bi-directional operation due to its ability to reverse the direction of rotation by reversing the polarity of the current flowing through the circuit. Figure 15 shows an electrical schematic representation of the stationary armature machine in said separately excited configuration wherein the electric current flowing through the field coil is regulated by means of an external exciter. The current circuit is completed through a shunt electrical connection

between said stationary armature and rotating field coil. Said separately excited configuration is useful in applications that require high torque, precise speed control, induced voltage regulation and bi-directional operation.

Figures